

THURSDAY, NOVEMBER 20, 1879

THE DOUBLE STARS

A Handbook of Double Stars. By Edward Crossley, F.R.A.S., Joseph Gledhill, F.R.A.S., and James M. Wilson, M.A., F.R.A.S. (London: Macmillan and Co., 1879.)

Double Star Observations made in 1877-78 at Chicago with the 18½-inch Refractor of the Dearborn Observatory, &c. By Sherburne Wesley Burnham, M.A. (From *Memoirs of the Royal Astronomical Society*, vol. xliv.)

IT cannot be said that a special work upon the double and compound stars has not been long a desideratum. Of the various branches of astronomical science the study of the double stars appears to have formed one of the most attractive to amateurs generally; so far as the reduction of the observations is concerned it involves little calculation, and the observations themselves are not laborious but admit of being proceeded with at intervals of leisure, with comparatively moderate appliances, at least in a large number of cases. Many of our amateurs have their daily duties and occupations in other lines, and seek relief in their evenings from the monotony of routine; the observation of the double stars upon a well-arranged list perhaps offers as favourable opportunities for rendering themselves really useful and for doing really good work in astronomy without the labour of one kind or another involved in several other classes of observation as it is possible to find.

The branch of astronomy to which we are referring has progressed as rapidly as others, and the observations of double stars and particulars relating to them have been scattered through a large number of astronomical publications, to consult which involves a great outlay of time and trouble, even if they are accessible without difficulty. The main purpose of the volume before us has been to present the great majority of measures of some twelve hundred double stars in a convenient form, with notes bearing upon binary character or other peculiarity, or, speaking generally, to furnish a history of each star. Part I. is introductory or explanatory, containing a brief historical notice and reference to those astronomers who have been most occupied upon the double stars, with particulars of the instruments employed, the adjustments of the equatorial, the micrometer and methods of observing with it, forms for registering measures and similar details. Part II., which possesses considerable value, treats of the calculation of the orbits of the revolving double stars, and in this division of the work the authors have been fortunate in being assisted by Dr. Doberck, who has a greater experience in this direction than any other astronomer of the day, and who has contributed in so important a degree to advance our knowledge of the elements of these revolving suns. Sir John Herschel's graphical process for determining the apparent orbit which is still of such material assistance towards more refined investigation is explained and illustrated (which is better still) by an application to Castor. This is followed by the calculation of an orbit by analytical methods, applied to σ Coronæ, the different steps being clearly

defined, but these methods are necessarily much more laborious, and at present we do not seem to get the full advantage in many cases that might be expected from them. It will be no fault of Dr. Doberck's if the computer does not succeed in obtaining elements upon the principles he so well explains, which will continue to represent the motion of the star. Other causes frequently operate, however, which appear to render elements less satisfactory for *prediction* than might be expected, considering the refinement used in their calculation. The comparison of Dr. Doberck's orbit of σ Coronæ with observation affords a very close agreement. In the next three chapters Mr. Wilson enters upon relative rectilinear motion, the effect of proper motion and parallax on the observed angles and distances of a star optically double, and the errors and combination of observations.

Part III., "the Catalogue and Measures," prepared by Mr. Gledhill, is that which will be most frequently consulted. Considerable care appears to have been taken in the selection of the objects, and in the collection of the measures by various observers. A great amount of trouble must have been expended upon this portion of the volume, which is well brought up to date, and few facts of importance bearing upon the history of any object appear to have been overlooked, though such omissions must almost necessarily occur sometimes in a work of this character. There has evidently been the wish to make this part of the work as useful as possible to the amateur. Perhaps in a short supplement to another edition it may be desirable to reproduce the double star measures with the Königsberg heliometer, collected in vol. xxxv. of the *Observations at that Observatory*, the more especially as these volumes of observations have but a small circulation in this country; we miss most of these measures in the "Handbook."

An appendix contains the positions and measures of two hundred of Mr. Burnham's new double stars, placed at the service of the authors by the discoverer. Part IV. is bibliographical, and supplies a list of the principal works and papers relating to double stars and upon various forms of micrometer.

The volume is one which may be expected to find its way to the shelves of most amateurs and students of astronomy.

Mr. Burnham's important contribution to vol. xliv. of the *Memoirs of the Royal Astronomical Society*, contains (1) a catalogue of 251 new double stars with measures, and (2) micrometrical measures of 500 objects, amongst them some very difficult ones and a number of evident binaries.

At the time the Chicago Astronomical Society was organised in 1862, Messrs. Alvan Clark and Sons had still in their possession an object-glass of 18½ inches aperture, which was then the largest in the world. Steps were taken to secure it, and, thanks to the energy of the Hons. Thomas Hoyne and J. Young Scammon, the latter of whom has been president of the Society from its organisation, the glass was secured for Chicago, and by means of a public subscription 18,000 dollars were raised for its complete mounting, and Mr. Scammon contributed 30,000 in addition for the building. Fortunately an observer equal to the use of so fine an instrument was at hand, and latterly Mr. Burnham has devoted it to the

discovery of new double stars and the revision of an extensive list of known ones which appeared most deserving of attention. He remarks: "My work has been wholly a labour of love. During the business hours of every day I have been otherwise fully occupied, and hence my observations have been prosecuted often at the expense of rest, sleep, and recreation. I submit the results to the Royal Astronomical Society as the first contribution of the great equatorial of the Dearborn Observatory." Mr. Burnham had however published, between 1873 and 1877, *nine* smaller lists of new double stars, containing 482 in all; the present catalogue brings up the number to 733; indeed, his energy and success have been alike extraordinary.

In looking over this tenth catalogue of new doubles, many objects are noted which deserve more or less attention. η Piscium, a star of the fourth magnitude, has a companion of the eleventh at a distance of one second, and "there is no known pair among stars of this magnitude or brighter, with so close and minute a companion." Three stars have been found near the celebrated variable, *Algol*, all three closer than Schröter's companion; one of 12.5m. is distant only 10".6 on an angle of 115°. There are also three new doubles amongst the Pleiades, and a much nearer companion to *Aldebaran* than that observed by Herschel and Struve. In an object in R.A. (1880°), 21h. 1m. 25s., and Decl. +43° 12', Mr. Burnham finds the most minute close pair known and terms it "a curiosity in double stars, if for no other reason;" it is too small for Argelander's *Durchmusterung*; the components are about equal and near 11m., distance 0".4. There are two faint companions to Herschel's "Garnet-star" in Cepheus, and not the least interesting addition is a *comes* of 12.5m. preceding nearly on the parallel, by 0".7, the star δ Pegasi, which has large proper motion and a sensible parallax according to the investigations of Prof. Brünnow at Dunsink; as Mr. Burnham remarks the physical connection or otherwise of the faint star should be soon decided.

In the second catalogue, as we have stated above, there are many binary systems, the Chicago observations either confirming previous deductions or indicating new objects in motion. Mr. Burnham doubts the duplicity of *Atlas Pleiadum*, though Struve considered that confidence might be placed in his measures of 1827, an inference somewhat supported by Dr. Hartwig's observation on the occultation of the star by the moon in 1876. An examination of the interior of the trapezium of Orion, afforded not the slightest suspicion of any additional stars, and hence Mr. Burnham concludes that several faint objects supposed to have been seen within it, with smaller telescopes, have no real existence, and he expresses the same opinion as to recent suspected companions of the Pole-star. He shows good reason for inferring that one of the components of Σ 1058 is variable; the brighter star is missing in more than one catalogue where it might be expected to be found, and in 1878 a thorough search did not reveal any double star near its place, but in the early part of the present year he has been more successful and has measured the star on two nights, when the magnitudes were respectively 8 and 11. A reference to Mr. Burnham's notes will afford a number of other objects to which special interest attaches.

OUR BOOK SHELF

The Saidapet Experimental Farm Manual and Guide.
By C. Benson. (Madras, 1879)

THIS volume is published by the direction of the Madras Government, and consists of a Report by the Superintendent of the more important results obtained at the experimental farm since its commencement in 1865. An agricultural college has been recently added to the farm establishment, but this educational work lies beyond the scope of the present volume. Of the value of the work done on this experimental farm there can be no question; the Government money spent on it has been well laid out. If the miserable and profitless native systems of agriculture are to be improved, and the land made capable of supporting the rapidly increasing population, it must be by the adoption of the methods here recommended.

In the native agriculture the soil is stirred to the depth of 3 inches only, manure is seldom employed, and grain crops are generally the only ones cultivated; the land is thus reduced to its lowest limit of productiveness. Irrigation is also most wastefully conducted. Eight to twelve feet of water are consumed in the production of a single crop of paddy, the ground being turned into a swamp, and frequently becoming a source of disease to the surrounding population.

The improvements recommended are in the first place a deeper cultivation of the soil, by which its porosity and water-holding power would be increased, and the root development of the crop favoured. An English plough is said to cost twenty-five times the price of a native implement, but the work done is so superior that the increased outlay will be repaid during a single year's cultivation of twenty acres. Many soils also require draining. The rainfall in India is at certain times of the year extremely heavy (16 inches have been recorded at Saidapet in twenty-four hours); on such occasions undrained land becomes for a long period unworkable, and much precious time is lost. Judicious drainage will not diminish the water holding power of heavy land, but rather increase it by promoting the disintegration of the subsoil. Drainage is also greatly needed in many cases for irrigated land; without this the water may become stagnant and its good effect greatly diminished.

The next improvement demanded is the adoption of a proper rotation of crops, in which fodder crops should hold an important place. The experiments have shown that a large number of excellent fodder crops exist, which can be cultivated if need be all the year round. The fodder crops most strongly recommended are cholum (*Sorghum vulgare*), and guinea grass (*Panicum jumentarium*). Sugar cane, where well manured, affords an immense amount of excellent fodder. Paddy may also be often usefully cut while green, and a good supply of fodder thus obtained when the quantity of water available is too small to carry the crop to maturity. Horse gram (*Dolichos uniflorus*) may also be grown with advantage as a fodder crop, and four or five cuttings may be obtained in the year. Being a leguminous plant, rich in nitrogen, it is of great use in bringing poor land into condition, and may be ploughed in as a green manuring with excellent effect.

One great object of the growth of fodder crops is to enable the farmer to raise the condition of his soil by applications of organic manure; to increase the amount of humic matter in the soil is a most important step towards amelioration in such a climate as that of India. The fodder crops should be consumed by cattle, kept, at least during the night, in loose boxes, and the manure thus obtained returned to the land. Other manures recommended are steeped cotton-seed, saltpetre, bones, and lime.

Until the condition of the land is raised by proper cultivation and manuring, a large number of improvements must remain impossible. Superior grain crops, and